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Deconstructing the Colorado River: Part I

The economics, law, and policy of the Colorado River may be on a collision course. Especially in the Lower Basin, water demands by consumptive users continue the steady march toward overwhelming the allocation scheme devised by the 1922 Colorado River Compact, the U.S. Supreme Court decision in *Arizona v. California*, and the Bureau of Reclamation's contracting policies. At the same time, changing operations of Glen Canyon Dam and the designation of virtually the entire Colorado River system as critical habitat for the protection of four endangered fish species will mean even less available water. From an economics perspective, the long-term market value of the Colorado River water remaining for consumptive uses must inevitably increase. And the rising market value of water will increase the stakes of parties in the emerging changes in the law and policy governing the Colorado River.

The major transformation of the Colorado River may commence this year. Historically, compacts, decrees, and

Reclamation contracts have controlled the allocation of Colorado River water. In the future, such documents may become, at most, the "starting points" for voluntary reallocations of water among consumptive users, the assignment of economic burdens from meeting urgent environmental objectives, or both. Not surprisingly, the federal government will occupy the center stage for at least the first act of the unfolding drama.

In this two-part series of articles, *WS* examines the stress on the Colorado River and the implications of the two most prominent federal actions in the immediate future: the designation of critical habitat and the pending regulations for administering entitlements in the Lower Colorado River Basin. While many would agree that the regulations will be important, perhaps some would express surprise about the importance of the designation of critical habitat.

Did not the Draft Economic Analysis of the Proposed Critical Habitat Designation anticipate minor economic effects (see *WIM December 1993*)? As explained below, the Draft Economic Analysis is deeply flawed. In fact, the federal process of designation of critical habitat promises to bring to the entire Colorado River Basin the same structural weaknesses in policy-making that crippled the setting of effective water quality standards for California's Bay-Delta (see "Unreasoned Explanation," *WS January 1989*; "Delta on Hold," *WS January 1992*). Misfires and misdirections in the federal management of the critical habitat issue will only intensify the pressures on the Colorado River.

With rapidly changing economic and regulatory demands, the issuance of Reclamation's long-delayed draft regulations for the Lower Colorado River takes added urgency. Based on the 1991 and 1992 versions of the draft regulations, Reclamation policy may be started in the right direction. But there is significant room for improvement if use of Colorado River water is to be guided by voluntary transactions rather than regulatory mandate (for discussion of the 1991 draft, see "Rules of the River," *WS October 1991*). The important draft, of course, is the one scheduled for release later this year. The specific language will shape the effectiveness with which water users and the federal government will address the changing pressures on the Colorado River.

Part I of this series discusses the emerging economic and regulatory pressures on the Colorado River. By the turn of the century, the Lower Basin's 7.5-million acre-feet per year (afy)

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"Deconstructing the Colorado River" is the first article in a two-part series on the economic stresses on the allocation of Colorado River water and the implications of the two most prominent federal actions in the immediate future: the designation of critical habitat and the pending release of regulations for administering entitlements to Colorado River water in the Lower Colorado River Basin.

The "1993 Annual Transaction Review" summarizes the trends from the 171 water transactions reported during 1993 in *Water Intelligence Monthly*. Drought and environmental concerns have aroused markets in all regions.

"Finance Update" reviews the results from the 178 bonds issued to raise \$2.84 billion in the fourth quarter of 1993.

"Litigation Update" reviews a Utah Supreme Court decision holding that a mutual shareholder may not file a change of diversion application without the company's consent.

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apportionment may be fully utilized, with California's and Nevada's demand for Colorado River water exceeding their respective entitlements. The designation of critical habitat may impose far greater economic costs than estimated by the U.S. Fish and Wildlife Service. Given the long lead times for negotiation of transactions and environmental reviews required for federal approvals, preparations must start today for the reallocations required to begin by the year 2000.

Part II will examine the implications of these trends for the proper design of Lower Colorado regulations. WS anticipates two possible scenarios: water management based on either voluntary transactions or regulatory mandate under which federal regulators exercise broad discretion. When one reviews the next version of the draft regulations for the Lower Colorado, remember, "the devil is in the details."

Context

Existing institutions, hydrologic conditions, and the pattern of water use on the Colorado River are the starting points for the evolution of federal policy.

The 1922 Colorado River Compact apportioned 17.5 million afy of water from the Colorado River among the Upper Basin (portions of northern Arizona, Colorado, New Mexico, Utah, Wyoming), the Lower Basin (remainder of Arizona, California, Nevada), and any U.S. treaty obligation to deliver water to Mexico (subsequently set at 1.5 million afy plus an additional 200,000 afy during times of surplus). Each basin received the right to use 7.5 million afy, including Indian water rights. The Lower Basin received an additional 1.0 million afy apportionment of water.

The basins' apportionments were subsequently divided as follows. In the Upper Basin, Arizona received an apportionment of 50,000 afy, with the remaining water divided among the Upper Basin states as follows: Colorado (51.75%), New Mexico (11.25%), Utah (23%), and Wyoming (14%). In the Lower Basin, the U.S. Supreme Court decision *Arizona v. California* held that when Congress passed the Boulder Canyon Project Act, it apportioned 4.4 million afy for California, 2.8 million afy for Arizona, and 0.3 million afy for Nevada.

Unfortunately, the 17.5 million afy apportioned by the 1922 Compact exceeds the amount of available water. During the period immediately preceding the 1922 Compact (1906-1921), the annual natural flow of the Colorado River averaged 18.1 million af. The Compact drafters must have believed that additional flows would be available for future apportionment—in fact, Articles III(f) and III(g) specify a procedure for future apportionment. Subsequent experience indicates that natural flows average considerably less than 17.5 million afy—annual natural flows averaged 15.2 million af during the 1906-1990 period. That is, the 1922 Compact may have apportioned 2.3

million afy of "phantom water." And if findings from tree-ring studies prove accurate (the long-term historic flow may be even less than 15.2 million afy), the Compact may rest on even a greater amount of phantom water.

A key assumption of the drafters that motivated the Upper Basin states to pursue the 1922 Compact, however, remains true—Upper Basin water development lags behind Lower Basin water development. In the Upper Basin, current consumptive use of the Colorado River is about half the basin's entitlement. In the Lower Basin, consumptive use in recent years has fluctuated around the basin's entitlement, but with significant differences among the Lower Basin states. During the 1987-1992 period, California has consistently used water in excess of its 4.4 million af entitlement as Arizona and Nevada have under-utilized their entitlements—see Table 1.

In sum, the laggard pace of water development in the Upper Basin has delayed reckoning with the disjunction between the historical apportionment of the Colorado River on the one hand, and hydrologic and economic reality on the other. Based on emerging trends, especially in the Lower Basin, the disjunction will get worse.

Changing Demands in the Lower Basin

There are two plausible scenarios for the future demand for Colorado River water in the Lower Basin. Common to both scenarios, urban demand in California and Nevada will grow briskly. The key difference involves Arizona: will the recently enacted policy addressing weak agricultural demand for Central Arizona Project (CAP) water be successful? If it is, the under-utilization of Arizona's Colorado River entitlement will decline within the next few years. If not, under-utilization will continue for perhaps a decade. But whether the "rapid CAP recovery" scenario or "slow CAP recovery" scenario prevails, the scope for voluntary water transactions could be substantial to bridge the discrepancy between existing apportionments and future water demands.

Table 1
Recent Historical Use of Colorado River Entitlements
in the Lower Basin (af)

Year	Arizona	California	Nevada	Total
1987	1,786,703	4,910,894	108,863	6,806,460
1988	1,973,388	5,058,818	129,420	7,161,626
1989	2,278,732	5,166,411	159,213	7,604,356
1990	2,296,632	5,242,975	178,111	7,717,718
1991	1,909,536	5,035,609	180,224	7,125,369
1992	1,950,027	4,567,795	177,551	6,695,373
Average	2,032,503	4,997,084	155,564	7,185,150
Entitlement	2,800,000	4,400,000	300,000	7,500,000

Source: Decree Records for *Arizona v. California*.

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California

Reflecting the apportionment of the state's entitlement, consumptive use of Colorado River water is dominated by agriculture. Water use in the four agricultural districts (Bard Unit of the Yuma Project, Coachella Valley Water District, Imperial Irrigation District, and Palo Verde Irrigation District) averaged 3.66 million afy during the 1987-92 period. Under the Seven-Party Agreement, the agricultural water districts have the right to use the first 3.85 million afy available under California's entitlement. The pattern of agricultural use reflects variations in gross value per acre, which was increasing in the late 1980s and decreasing in the 1990s, as well as the recent land fallowing agreement between Palo Verde and the Metropolitan Water District of Southern California (MWD).

As is widely known, MWD currently relies on the unused entitlements of other parties in the Lower Basin states, primarily non-Californians. MWD's consumptive use averaged 1.2 million afy during 1987-1992, considerably above its Colorado River entitlement commonly believed to be 550,000 afy — the difference between California's 4.4 million afy entitlement and the 3.85 million afy entitlement of the agricultural districts. In fact, MWD's entitlement, the most junior among all of California's entitlements, is even less. Under *Arizona v. California*, the Chemehuevi, Yuma, Colorado River, and Fort Mojave Indian Reservations in California were awarded reserved water rights for the diversion of up to 131,400 afy for the irrigation of 19,975 acres, whose consumptive use is charged against California's entitlement. Since Indian reserved rights are the most senior in the Lower Basin, the exercise of these rights takes precedence over MWD's. With the other reserved rights for federal establishment and the other present perfected rights granted individuals, MWD's *de facto* entitlement is arguably 458,500 afy — California's 4.4 million afy entitle-

ment, less the 3.85 million afy agricultural entitlement, less 65,500 afy for the consumptive use of Indian rights (assuming half the diversions are consumptive use), less 25,000 afy for federal establishment rights and miscellaneous present perfected rights. In other words, MWD's recent use of Colorado River water is perhaps 2.7 times its "firm" entitlement.

But municipal demand requires long-term reliable supplies, not short-term surplus supplies (see "Having Water on Tap," *WS April 1988*). Therefore, even if MWD does not demand any new supplemental water supplies, MWD's demand for long-term, firm entitlements may be on the order of 541,500 afy — MWD's 1,200,000 afy use, less 458,500 afy existing entitlement, less 200,000 afy from the funding of water conservation projects and the lining of the All American Canal in the Imperial Irrigation District.

MWD's demand for additional firm Colorado River supplies may exceed 541,500 afy. According to the draft 1993 California Water Plan, the South Coast basin is faced with substantial future water shortages. After taking into account water conservation, water demand is projected to grow between 1990 and 2010 by 940,000 afy during average water years and by 978,000 afy during drought years. Water demands are projected to increase by about another 600,000 afy between 2010 and 2020.

The South Coast does not have sufficient water to meet projected demands. During average water years, projected water shortages will reach 500,000 afy by 2010 and 986,000 afy by 2020 with supplies only from existing facilities — see Figure 1a. During drought years, projected water shortages will reach 1,699,000 afy by 2010 and 2,296,000 afy by 2020 with supplies only from existing facilities — see Figure 1b. If Level I Programs are implemented (*e.g.*, including new supplies from options extensively investigated with "high" likelihood of implementation), the projected shortages are substantially smaller, but still significant. By 2020, projected shortages would reach 373,000 afy during average water years and 1,001,000 afy during drought years.

The projections with supplies from existing facilities may

Figure 1a -- Water Shortages in S. Coast During Average Years

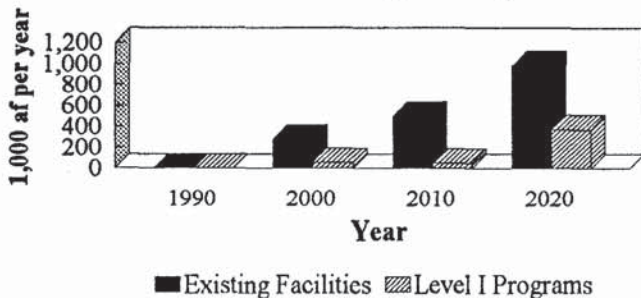
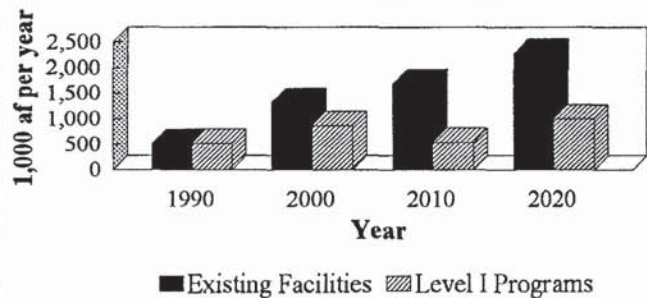


Figure 1b -- Water Shortages in S. Coast During Drought Years



be more realistic than those with supplies including Level I Programs. The difference concerns the expansion of the State Water Project and the growth of reclaimed water. Under Level I options, the South Coast would receive an additional 1 million afy from the State Water Project during average water years and 800,000 afy during drought years. It would also receive an additional 281,000 afy from new reclaimed supplies (a 2.7-fold increase). Many would be especially skeptical about both assumptions, especially about additional yield from the State Water Project.

The projected shortages in the South Coast basin are probably even further understated. The projections assume that the State Water Project will operate under water quality standards in the State Water Resources Control Board's Decision 1485. The implementation of proposed federal water quality standards for the Bay-Delta, however, would substantially reduce the yield of the State Water Project from the amount available under D-1485 standards (see *WIM December 1993*). If so, the structural shortage faced by the South Coast basin may be substantially understated.

California's municipal demands for Colorado River water will intensify. MWD lacks long-term firm entitlements for its existing use of Colorado River water. It faces a dramatic long-term structural shortage. Especially if environmental regulation prevents acquisition of significant quantities of water from Northern California, the South Coast basin must combine three strategies:

- aggressively acquire additional supplies from the Colorado River
- substantially increase water rates and impose mandatory rationing to reduce per capita water use by 30 to 40 percent
- forego a significant portion of the economic growth implicit in the demand projections

The three adjustments portend an increased value for access to Colorado River water by MWD.

Nevada

Within the past few years, the rapid growth in municipal water demand of the Las Vegas area has been legendary. By the late 1980s, growth in demand over-ran the Las Vegas Valley Water District's groundwater rights and entitlement to the Colorado River (see "Having Water on Tap," *WS April 1988*). The pressure on Las Vegas's water resources continues.

For the past ten years, population in Clark County has grown at a steady rate of 5 percent per annum. In 1993, water production by the Las Vegas Valley Water District reached 252,000 af, about 14 percent groundwater and 86 percent surface water. If population growth continues at the same rate (as expected), Nevada may exhaust its entitlement by the year 2006, if per capita water use remains constant or by the year 2010 if per capita water use declines by 1 percent per annum — see Table 2. While deeper cuts in per capita use could delay when Nevada exhausts its entitlement until 2020, the implied

Table 2
Projected Year of Exhaustion of Nevada's Entitlement

<i>Annual Reduction in Per Capita Use</i>	<i>Year Entitlement Exhausted</i>	<i>% Cumulative Reduction in Per Capita User</i>
0	2006	0
1	2010	16
2	2015	36
3	2022	64

reductions in per capita water use may be draconian. While a 3 percent per annum decline in per capita use can defer exhaustion of the state's entitlement to the year 2022, per capita consumption in that year must be 64 percent less than per capita consumption in 1993.

Nevada officials, of course, have been in aggressive pursuit of new supplies. In 1989, Las Vegas filed applications to appropriate new surface and groundwater supplies in rural areas. Predictably, these applications proved controversial; opponents feared the effects on local economies and the environment. In 1991, major local entities in Southern Nevada formed the *Southern Nevada Water Authority* to act jointly on water supply, management, and conservation in Clark County, including water acquisitions (see *WIM November 1991*).

Perhaps the most dramatic action was the recent "Water Summit" held by the Colorado River Commission of Nevada and the Southern Nevada Water Authority. Proposals included schemes to import water from Alaska, Canada, and the Columbia River, purchase of water from Arizona's Colorado River entitlement, purchase of groundwater from Arizona and Nevada, exchange desalted water in Mexico for smaller deliveries of Colorado River water to Mexico, and the tapping of a "secret" underground river in Nevada whose annual flow may reach 18 million af. Consider proposals that portend an interstate market in the Lower Basin, an Upper Basin/Lower Basin market, or even an international market.

Consolidated/Geare proposed to make a minimum of 22,170 af of water available from the Cibola Valley Irrigation and Drainage District in Arizona through the retirement of 3,695 acres (the district's total diversions from the Colorado River averaged 23,300 af during the 1988-1992 period). The initial offer is a 10-year forbearance and banking lease that may be converted to a perpetual agreement during the first 5 years of the lease. The initial lease price is \$100/af for the first 3 years, then \$185/af for the remaining 7 years. The perpetual right may be acquired at a price of \$3,000/af, less any credit generated under the lease at a rate of \$32/af per year.

Nevada also received proposals to purchase Arizona groundwater for later exchange for water available under Arizona's Colorado River entitlement. One proposal involved a holding company in control of an Arizona ranch within 50

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miles of the Colorado River but within two miles of the CAP. The ranch is believed to have an estimated 100-year supply of 90,000 afy of groundwater. Under a proposed 100-year agreement, Southern Nevada would purchase and deliver CAP water to the ranch. At a future date, say 2010, Southern Nevada would divert an additional 70,000 afy from the Colorado River. To replenish the reduction in water available to the Central Arizona Project, 70,000 afy would be pumped from the ranch for CAP use. The group requested payment over the 100-year period for a price established by negotiation.

Nevada also received proposals for the transfer of Upper Basin water. Chevron and Getty proposed their Roan Creek Project involving the lease of water rights in Colorado previously planned for use in oil shale development (for background on Colorado's reaction, see *WIM February 1993*). The project involves 175,000 afy of firm annual supply. The companies offer the water at the costs associated with project design, construction, and land acquisition (estimated at \$212.7 million), plus "other previously incurred and prospective costs associated with development, permitting, mitigation, and water court proceedings," plus all operating and maintenance costs incurred during the term of the 30 to 50 year lease.

Another proposal involved the sale or lease of four Colorado water rights totaling 145,000 afy located near the Colorado-Utah border. The rights are offered under three scenarios: (1) purchase for \$9.5 million, (2) 4-year option to purchase rights with annual payments of \$950,000 and a final purchase price of \$12.92 million, or (3) a ninety-nine year lease with an initial payment of \$4.75 million, future payments of \$40/af of delivered water, with a minimum annual payment of \$3.878 million.

Finally, Nevada received proposals with a Mexican connection. The State of Alaska suggested that Las Vegas apply for water rights in Alaska that would be exported to Mexico by tanker or towed bags. In return, Mexico would receive less Colorado River water, which could be diverted by Las Vegas. Alaska believes that bulk water exports to either California or northern Mexico would cost between \$500 to \$2,000 per afy, depending on the point of take and delivery and the method of transport. U.S. Senator Ted Stevens has asked the Congressional Office of Technological Assessment to review a third party assessment of the concepts. Alaska believes that it can export up to 1 million afy through the use of proven marine transport technology. Another company proposed that Las Vegas pay for the construction and operation of desalination plants in Mexico and exchange the water for increased use of Colorado River water.

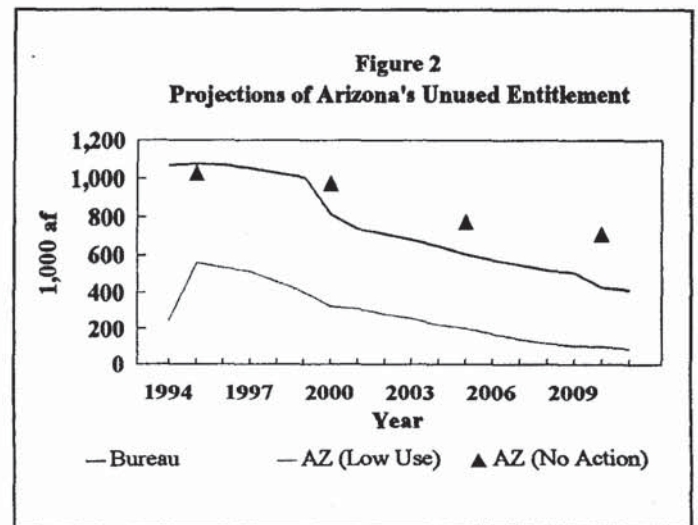
In sum, the under-utilization of Nevada's Colorado River entitlement will evaporate within the planning horizons of municipal water supply systems. New pressures have erupted on the Colorado.

Arizona

Unlike her sister states, Arizona finds itself in the position of chronic under-utilization of its entitlement. In the past two years, its use of Colorado River water has been about 1 million af less than its 2.8-million afy entitlement. This under-utilization reflects the fiscal stress of CAP agricultural contractors (see "CAP Under Economic Stress," *WS October 1992*). The resolution of CAP's problems will make a significant impact on the short-term availability of Colorado River water for California.

Figure 2 illustrates different assumptions about the amount of unused Arizona entitlement through the year 2011. In May 1993, Reclamation conducted a study of banking policies for the Lower Colorado. The solid-bold line shows the study's implied assumption that Arizona's unused entitlements will remain above 1 million afy until the turn of the century, and then steadily decline thereafter reaching 500,000 afy by the year 2009. In general, this projection corresponds to the projections recently prepared by Arizona's Department of Water Resources if "no action" is taken to resolve the CAP's financial crisis. However, other projections prepared by Arizona's DWR portend a different story. The *Governor's Task Force on Central Arizona Project Issues* (September 1992) projected water use under two scenarios—low agricultural water use and high agricultural water use. Even under the low-use scenario (the dashed line in Figure 2), Arizona's unused entitlement will decline to 400,000 afy by the turn of the century, and steadily taper off to 100,000 afy by the year 2009.

The actual under-utilization of Arizona's entitlement will probably fall short of the levels assumed by Reclamation. Arizona continues to work intensively to find policies that utilize its full entitlement. The formation of Groundwater Replenishment Districts will encourage substitution of CAP water for groundwater. The Central Arizona Water Conserva-



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tion District has recently announced a policy in which agricultural contractors may waive their contract rights for CAP water, thereby avoiding "take-or-pay" liability that would otherwise force districts into bankruptcy and to stop ordering CAP water. In return, they become eligible to purchase CAP water at lower rates. In January, six of the seven irrigation districts served by the CAP exercised this opportunity (WIM February 1994).

Only time will tell if and when Arizona will resolve its under-utilization of its entitlement. However, the CAP has leased 700,000 af in 1994 under its new policies (WIM February 1994). If non-CAP users of Colorado River water use the same amount in 1994 as their average amount in the 1990-92 period (1.44 million af), then Arizona's use of the Colorado River water in 1994 may top 2.14 million af. While 660,000 af of unused entitlement is still substantial, it would be 200,000 af less than in 1992 and 44 percent less than the amount assumed in Reclamation's 1993 banking study.

Critical Habitat Designation

The first major federal action this year is the designation of critical habitat for four endangered fish species: the Razorback Sucker, Humpback Chub, Colorado Squawfish, and Bonytail. The cumulative designation of critical habitat along the Colorado River for the four fish species are as follows: razorback sucker (3,649 miles), bonytail (682 miles), humpback chub (758 miles), and Colorado squawfish (2,296 miles). Since there is considerable overlap in the proposed critical habitat for the species, the total miles of critical habitat for all four species is less than the sum of the above amounts.

The U.S. Fish and Wildlife Service anticipates the economic effects of the designation to be minor (WIM December 1993). For the entire Colorado River Basin, the proposed designations are estimated to increase income by less than \$10 million annually over the 1995-2020 period. California would gain the most (\$13.1 million per annum). The other basin states would lose (especially New Mexico and Utah with annual income losses of \$3.0 million and \$3.2 million, respectively), except for Colorado, which is estimated to enjoy *de minimus* gains (\$0.1 million per year).

For a study devoted to reporting estimates in great numerical detail (e.g., by the year 1995, designation estimated to reduce employment in New Mexico by 1.78 jobs, but increase employment in the Colorado River basin by 28.88 jobs), it is woefully inadequate. Most prominently,

- it understates the effect of designation on water available for consumptive uses in both basins;
- it does not demonstrate how the assumed actions will meet environmental objectives;
- it systematically makes assumptions that underestimate the economic effects of proposed actions.

But the analytic transgressions may be less than the political transgressions of exposition.

Unless one examines the technical appendix, one does not uncover the study's key assumption: designation of critical habitat will stop virtually all future water development in the Upper Basin. Especially given the Clinton Administration's commitment to its trustee responsibility for Indians, perhaps the most conspicuous implication of the study's assumption is that development projects on many Indian reservations will be canceled. As the viability of the study's assumed actions becomes questionable as a matter of law, politics, and policy, the relevance of the study's findings for understanding the economic consequences of critical habitat designation fades into oblivion.

Understated Effects on Water Availability

There are two reasons why the report understates how the designation of critical habitat affects water availability. First, for most of the tributary streams and rivers, flow recommendations are not available. Therefore, the study only considered the implications for flow rates at ten sites in the Upper Basin and two sites in the Lower Basin. Second, for the sites considered, the study used a flawed method to determine when designation would create a shortfall in the quantity of water available for consumptive uses.

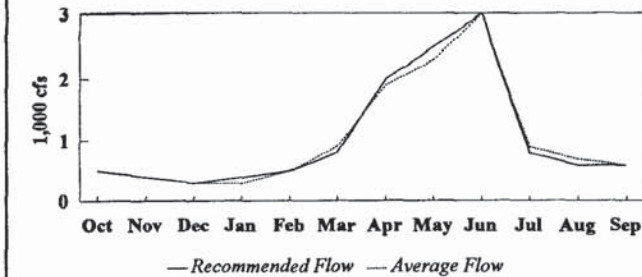
For each gauge site, the report uses hydrographs comparing water flows under current and future planned uses with recommended flows for three types of water years — dry, average, and wet. When flows under current uses or future planned uses are less than recommended flows, the report assumes that critical habitat designation will require adjustments in water uses. The flaw in the analysis is demonstrated by the following hypothetical example.

Consider a gauge site with a hydrograph like Figure 3 for, say, an average water year. The average monthly flows under current and planned future uses and the recommended flows are equal (1,030 cfs). For the months of January, April, and May, recommended flows are slightly greater than average actual flows. For the months of March, July, and August, recommended flows are slightly less than average actual flows. For the remaining months, the recommended flows and actual flows are identical. Given the discussion in the technical appendix of actual hydrographs used in the study, the draft economic analysis would conclude that, but for restrictions on the timing of flows, the recommended standards would be presumed to have no effect!

Focus on averages, of course, neglects the implications of variability around averages. Suppose, for example, that actual monthly flows fluctuate around average monthly flows for an "average" water year so that:

- two-thirds of the time, actual monthly flows are within plus or minus 15 percent of average monthly flows; and
- ninety-five times out of a hundred, actual monthly flows

Figure 3
Recommended Flows v. Average Flows



are within plus or minus 30 percent of the average monthly flows. That is, a significant portion of the time, *actual* monthly flows will be below recommended flows, even though *average* monthly flows equal or exceed recommended flows.

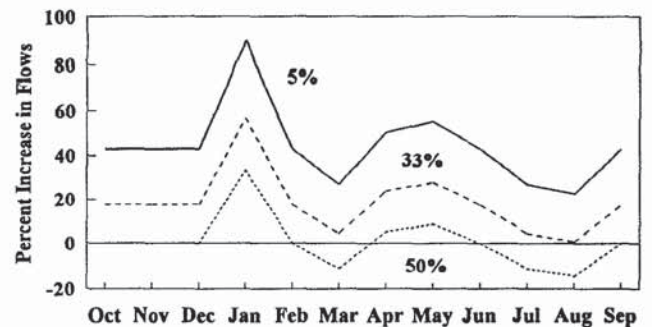
Figure 4 summarizes the enhanced flows required to meet recommended flows for habitat protection under different "exceedance levels" for the hypothetical example (the 5% exceedance level, for example, measures the maximum flow occurring in 5% of average water years). In 5 percent of the average water years, actual flows must be increased by 80 percent in January and 50 percent in April through June to meet recommended flows. In one-third of the average water years, flows must be increased by 50 percent in January and 20 percent in April through June. Only less than half the time will no additional flows be required to meet recommended flow levels. A comparable analysis would apply to the recommended flow rates for dry years and wet years.

Since there is sufficient water "on average" to meet recommended flows, the study assumes that there is no problem meeting standards. This is fallacious reasoning. The draft economic analysis ignores the economic consequences from the periodic requirement that flows be increased to meet the recommended standard. That is, the study ignored the effect of the designation of critical habitat on the most valuable dimension of water rights, their reliability.

Will Assumed Actions Achieve Goals?

In general, when recommended flows exceed actual flows, the study only examines the economic consequences from forgoing future planned water development. Presumably, the study does so because, since project construction must proceed under the §7 consultation process of the Endangered Species Act, the federal government will exert its greatest leverage over construction projects. From an environmental perspective, the greatest problem with the draft study is that it does not demonstrate that cancellation of future water development alone will

Figure 4
Enhanced Flows to Meet Standard



achieve the recommended flows.

Consider, for example, the situation of the Colorado River at the Cameo gauge in the state of Colorado. During dry and average years, recommended flows exceed average actual flows for current uses, let alone for future uses. The study notes that "it is not known exactly how often biological flow targets need to be met to ensure recovery of endangered fish." It observes, however, "unless (the) decline (in fish populations) can be reversed under provisions of the Upper Basin RIP (Recovery Implementation Program), there may be impacts to the Colorado economy from foregone water development." The study then estimates the economic impact of canceling future water development.

Even if *all* future development was canceled, actual flows would still be less than recommended flows. The study, therefore, estimates the economic effect of critical habitat designation without considering all the actions necessary to achieve the recommended flows. If the U.S. Fish and Wildlife Service accurately estimated the flows necessary for fish recovery, the draft economic study does not estimate the economic consequences of *all* actions needed to assure recovery of the endangered fish.

The analysis of designation of critical habitat in the Lower Basin is likewise incomplete. Since there is little planned future water development, the study notes that §7 consultation under the Endangered Species Act will only be triggered if "there is a change in the amount of water depleted or the method of diversion" (emphasis added). But what will happen if actual flows remain below recommended flows? Again, if the U.S. Fish and Wildlife Service accurately estimated the flows necessary for species survival, then federal policy-makers will face two alternatives:

- witness further declines in fish populations, or
- undertake additional actions to enhance flows for species survival

But what actions will be undertaken? Will water transactions

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be asked to carry the burden for enhancing flows for the recovery of endangered fish?

The Lower Basin's other problem is that the lack of knowledge about flow requirements. For the Colorado River, Gila River, Salt River, Verde River, and the Little Colorado River in Arizona, the required flows are "unknown." For California, "the biological flow requirements for endangered fish in the lower Colorado River below Lake Havasu (MWD's diversion point) are unknown"; although the report notes the absence of any evidence indicating that diversions below Lake Havasu are harmful. For Nevada, the assumption is that the diversions from Lake Mead are not harmful to endangered fish; the report does concede that the outcome of §7 consultations for expanding diversions "cannot be predicted with certainty."

In sum, the report does not demonstrate that the actions included in the estimate of the economic effects of critical habitat designation will, in fact, promote fish recovery.

Underestimate of Economic and Political Consequences

For three reasons, the draft study underestimates the economic consequences of designation of critical habitat. First, it understates the effects on water availability for consumptive uses from an attempt to meet recommended flows (see discussion of figures 3 and 4). Second, if the cancellation of Upper Basin projects prove inadequate and/or any flow standards are discovered for the Lower Basin, what will happen? Will flows be allowed to fall below recommended levels? Or will current uses face a reduction in available supplies? The draft study neglects the economic consequences of the latter alternative. Finally, the study probably seriously understates the economic and political consequences of the studied actions.

Once again, consider the example of the Colorado River at the Cameo gauge. Recall that flows under current uses alone are less than recommended flows, thereby jeopardizing the viability of any future water development. According to Reclamation, depletion of the Colorado River in Colorado are expected to increase from 870,000 afy in 1993 to 1,072,000 afy by the year 2020, primarily for municipal and industrial purposes. Many of the planned projects on Upper Colorado River tributaries have already undergone §7 consultation with the U.S. Fish and Wildlife Service. Therefore, the draft study assumes, these projects would not be affected by proposed critical habitat designation. But development of 71,000 afy of Colorado River water has not undergone §7 consultation. This development is assumed to be canceled.

The draft study assumes that municipalities in the Denver area will replace the 71,000 afy by acquiring water through the retirement of 40,570 acres. Based on crop patterns, yields, prices, and water requirements in Weld County, the retirement of such acreage is estimated to reduce state agricultural output

by \$5.9 million in the year 2000 and by \$15.0 million in the year 2020. The study does not compare whether these estimates conform with the market value of such water rights. Nor does the draft study consider if there would be other costs incurred during the execution of the transactions.

In conjunction with assumed transactions needed to offset the assumed cancellation of development projects on the Yampa River, the draft study in effect assumes that designation of critical habitat would prompt municipalities in Colorado to acquire a total of 92,000 afy — the proximate annual yield of Denver's ill-fated Two Forks project. The political implications of land retirements and transactions on this scale are not considered. Of course, past proposals for land retirements and transactions on this scale, such as the ill-fated proposed acquisition of the Fort Lyon Canal Company, have prompted intense political opposition in Colorado (*WIM January 1992*).

Water development for Native Americans is also assumed to be canceled. For the Navajo Nation in New Mexico, development of 133,000 afy as part of the Navajo Indian Irrigation Project would not be built in order to meet flow recommendations on the San Juan River. For the Uintah and Ouray Indian Reservation in Utah, a 24,000 afy project would not be built to meet flow recommendations on the White River. The draft study estimates the foregone economic development as small (by the year 2020, \$19.1 million annually for the Navajo Nation and \$919,000 for the Uintah and Ouray). But the political implications for relations with these Native Americans are not assessed.

Finally, the study ignores the potential for designation to intensify the pending conflict between the Upper and Lower Basins over the apportionment of Colorado River water. Once again, the bottom line of designation is buried deep in the technical appendix: because of foregone development in the Upper Basin, an additional 257,400 afy (after evaporation losses) will be made available for use in the Lower Basin. Will the federal Endangered Species Act be the mechanism for (uncompensated) transfers from the Upper Basin to the Lower Basin?

Conclusion

Since the 1922 Compact, the history of the Colorado River has been a story of lagging development in the Upper Basin and under-utilization of entitlements in the Lower Basin. Times are changing. Economic and environmental pressures are about to overrun historical methods of apportionment. Because of designation of critical habitat, the reliability of water supplies will diminish. Parties that are lulled by today's unused entitlements will be out-competed by parties that position themselves today for the changed circumstances of the future. In Part II, *WS* will examine the implications of the trends for the proper design of federal regulations governing entitlements in the Lower Basin. □